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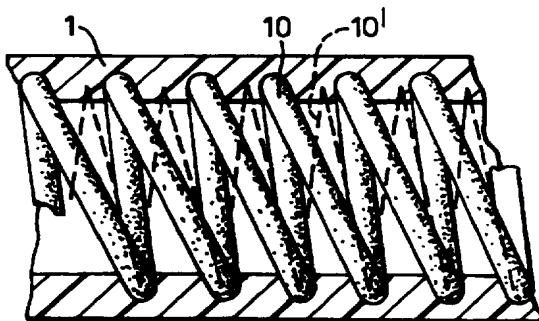
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(54) Abstract Title  
**Tube with helical reinforcement**

(57) The tube, e.g. endotracheal, cardiology, urology or enteral feeding catheter, or industrial has a wall e.g. of PVC and a reinforcement filament 10 of a harder plastics wound with a canted helical form so that adjacent turns of the filament slope at angles of 70° and 80° respectively in the plane of curvature of the tube. The filament 10, of rectangular or circular section, is of polyester, nylon, polythene, polypropylene or metal. The tube is made by extruding the base tube, winding the reinforcement 10 around the outside and then a further coating of PVC, polyurethane or TPE is applied e.g. by dip moulding.

**Fig.2.**



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Fig. 1.

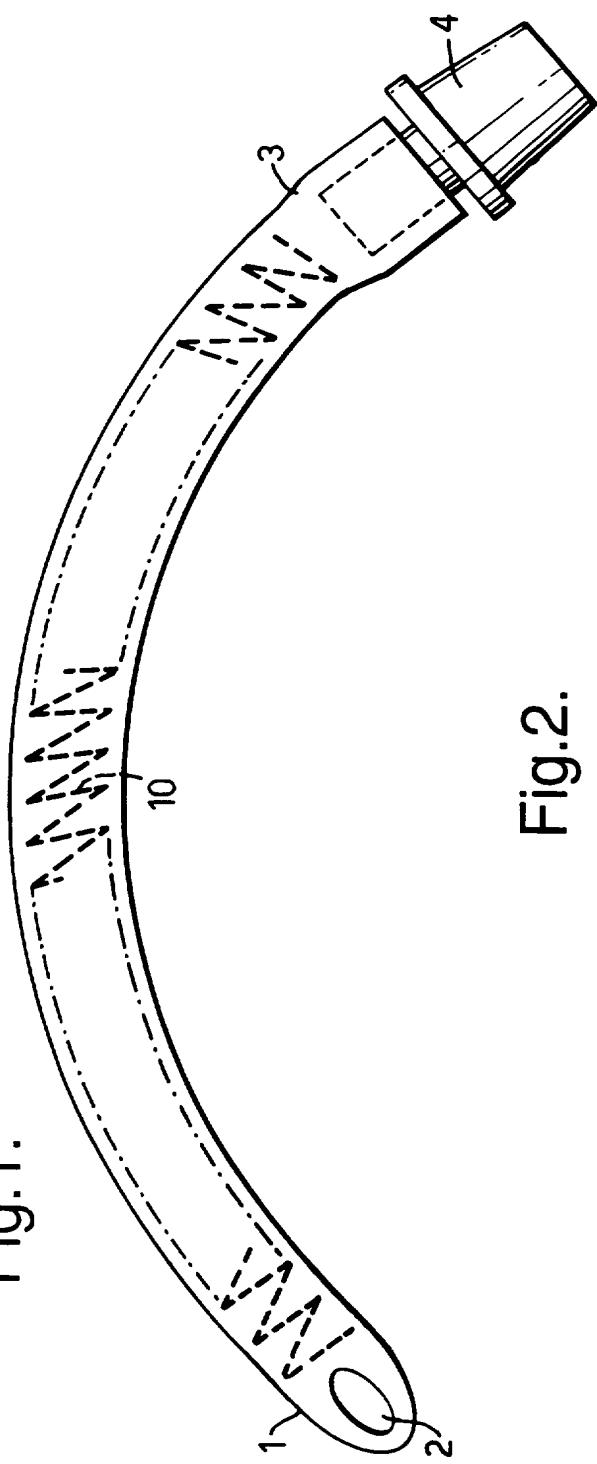
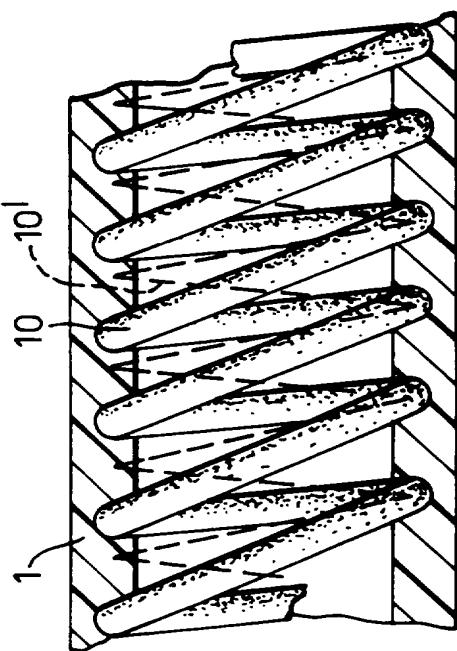


Fig. 2.



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Fig.3.

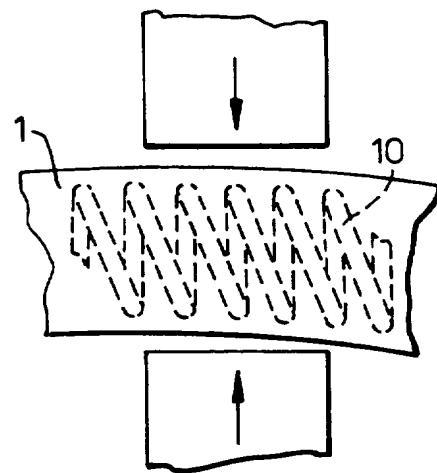
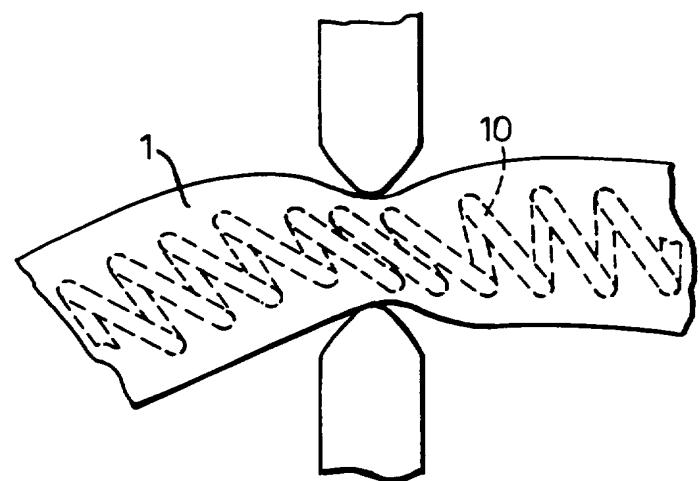


Fig.4.



TUBES

This invention relates to tubes.

The invention is more particularly concerned with reinforced tubes, such as for medical or surgical use.

It is known for medical tubes to be reinforced by the inclusion of a helical reinforcing element. Such a helical reinforcing element helps reduce the risk that the tube will be occluded by lateral forces and thereby enables the tube to have a thinner wall. Although such a reinforcing element increases crush resistance, compared with an unreinforced tube, the reinforced tube is still susceptible to crushing where a lateral force is exerted in a region narrower than the pitch of the reinforcing element. The tube is also still susceptible to kinking if the tube is bent around a small radius.

Examples of reinforced tubes and their manufacture are described in GB2043201 and GB 2321095.

It is an object of the present invention to provide an improved reinforced tube.

According to one aspect of the present invention there is provided a tube having first and second ends and a bore extending therethrough for the passage of fluid along the tube, the wall of the tube including a reinforcing element of a canted helix form.

Adjacent turns of the reinforcement element preferably slope in the same sense when viewed in elevation, such as at angles of 70° and 80° respectively. The tube is preferably curved along its length, the reinforcement element being canted in the plane of curvature of the tube. The reinforcement element may have a rectangular section. The wall of the tube may be of a first plastics, such as PVC, and the reinforcement element may be of a second plastics, such as polyester or nylon, different from the first.

The tube may be a medico-surgical tube such as an endotracheal tube in which the first end is adapted for location in the trachea and the second end is adapted to extend from the mouth of the patient.

According to another aspect of the present invention there is provided a method of making a reinforced tube including the steps of forming a base tube, wrapping around the base tube a reinforcement filament in a canted helical fashion by longitudinally oscillating a shuttle as the filament is wrapped, and applying an outer layer of material over the filament.

The base tube is preferably made by extrusion.

An endotracheal tube according to the present invention, will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a side elevation view of the tube;

Figure 2 is a side elevation view of a part of the tube to a greater scale; and

Figures 3 and 4 are side elevation views illustrating the effect of lateral forces applied to the tube.

With reference first to Figures 1 and 2, the endotracheal tube is of PVC, having a circular section with an external diameter between about 3 mm and 12 mm and a wall thickness between about 1 mm and 2.5 mm. The tube is typically about 300 mm long and is curved along its length with a radius of curvature of about 140mm. The patient end 1 of the tube is bevelled to one side and has a Murphy eye 2 of conventional kind. The machine end 3 of the tube is fitted on a male fitting at one end of a connector 4, the other end of which is shaped to receive a mating coupling, such as connected to a patient ventilation circuit (not shown). The tube may have an inflatable cuff (not shown) close to its patient connected via an inflation lumen to a pilot balloon and connector. As so far described, the tube is conventional.

The tube includes a reinforcing element 10 extending from a location just rearwardly of the Murphy eye 2 to a location just forwardly of the machine end 3. The reinforcing element 10 is a polyester or nylon filament of rectangular section and about 0.25 mm thick wound into a canted helical path. Alternatively, the filament could have a circular section, although the rectangular section helps reduce the wall

thickness. The filament could be made of other materials, such as metal, polyester, nylon, Kevlar, polythene or polypropylene. The difference between a canted helix and a conventional helix is illustrated in Figure 2 where the conventional helix is shown as a broken line 10' and the canted helix reinforcement filament 10 is shown as a full line. When viewed in elevation, a conventional helix has a sawtooth appearance, with opposite slopes of each tooth having equal and opposite angles. By contrast, a canted helix viewed in elevation, in the canted plane, has the two slopes of each tooth at different angles, one being steeper than the other. In effect, the canted helix is shaped as if one side of a conventional helix has been pushed longitudinally relative to the other side. In particular, in the present invention, the canted helix preferably has one slope canted in the same sense as the other slope at an angle close to vertical. Typically the slope angles of the two slopes might be 70° and 80°.

One advantage of the canted helix filament 10 can be seen when the effect of a lateral force on the tube is considered, as illustrated in Figures 3 and 4. If a lateral force were exerted over a length of the tube corresponding to several pitches of the reinforcement element, as shown in Figure 3, a high force would be required to compress the tube because one slope of the element is almost vertical to the applied force. If the lateral force were, instead, exerted over a short length of the tube less than the pitch of the reinforcement element 10, as shown in Figure 4, the effect would be to compress adjacent turns of the element towards one another. This has the effect of increasing the strength of the tube as the turns of the reinforcement element 10 are compressed closer towards one another. Such a localized force might be applied, for example, by teeth biting the tube. With a conventional helical reinforcement, a

localized force of this kind would just separate the turns of the reinforcement. The canted reinforcement element 10 thereby gives the tube a greater resistance to crushing in the canted plane than a tube with a conventional helical reinforcement element.

The reinforcement element 10 is canted in the plane of curvature of the tube, that is, the turns of the reinforcement element along the outside curvature of the tube are displaced longitudinally relative to the turns along the inside curvature. This ensures that the tube has the greatest resistance to crushing from lateral forces in the plane of curvature, which is where the majority of forces, such as from a teeth bite, will be experienced in an endotracheal tube.

When a tube is bent, there is a zone of compression on the inside of the bend and a zone of extension on the outside of the bend. With the tube of the present invention, there will be a greater number of turns of filament located in a compression/extension zone of given length, than in a conventional tube, so the energy produced on bending will be diverted more efficiently, with less risk of kinking. This reduced risk of kinking applies in all planes, but especially in the canted plane.

The tube is made by extruding a base tube of PVC and then winding the reinforcement filament around the outside of this in a canted helix fashion, by means of a shuttle that oscillates longitudinally as the filament is wrapped around the tube. The reinforcing filament is then retained on the base tube by a further extrusion such

as of PVC, polyurethane, or TPE, or by a coating, such as applied by dip moulding. Each tube may be made individually, with unreinforced portions left at opposite ends of the tube. Alternatively, a continuous length of tubing may be reinforced, which is then cut to length, the reinforcement element being removed from the end portions. In some tubes it may be unnecessary to have unreinforced end portions.

The invention is applicable to other tubes with a passage for conveying fluid. These may be medical tubes, such as, for example, cardiology catheters, urology catheters and enteral feeding catheters, or tubes for other applications such as industrial hoses.

CLAIMS

1. A tube having first and second ends and a bore extending therethrough for the passage of fluid along the tube, wherein the wall of the tube includes a reinforcing element of a canted helix form.
2. A tube according to Claim 1, wherein adjacent turns of the reinforcement element slope in the same sense when viewed in elevation.
3. A tube according to Claim 1 or 2, wherein adjacent turns of the reinforcement element slope at angles of substantially 70° and 80° respectively.
4. A tube according to any one of the preceding claims, wherein the tube is curved along its length and wherein the reinforcement element is canted in the plane of curvature of the tube.
5. A tube according to any one of the preceding claims, wherein the reinforcement element has a rectangular section.

6. A tube according to any one of the preceding claims, wherein the wall of the tube is of a first plastics and the reinforcement element is of a second plastics different from the first.
7. A tube according to Claim 6, wherein the wall of the tube is of PVC and the reinforcement element is of polyester or nylon.
8. A medico-surgical tube according to any one of the preceding claims.
9. An endotracheal tube according to Claim 8, wherein the first end is adapted for location in the trachea and the second end is adapted to extend from the mouth of the patient.
10. An endotracheal tube substantially as hereinbefore described with reference to the accompanying drawings.
11. A method of making a reinforced tube including the steps of forming a base tube, wrapping around the base tube a reinforcement filament in a canted helical fashion by longitudinally oscillating a shuttle as the filament is wrapped, and applying an outer layer of material over the filament.

12. A method according to Claim 11, wherein the base tube is made by extrusion.
13. A method of making a reinforced tube substantially as hereinbefore described with reference to the accompanying drawings.
14. Any novel and inventive feature as hereinbefore described.



**Application No:** GB 9824930.3  
**Claims searched:** 1-13

**Examiner:** Roger Binding  
**Date of search:** 2 February 1999

**Patents Act 1977**  
**Search Report under Section 17**

**Databases searched:**

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): F2P (PC11, PC25, PC26, PM9)

Int Cl (Ed.6): F16L 11/08, 11/10, 11/11, 11/112, 11/115; A61M 16/00, 16/04, 39/00,  
39/08

Other: Online WPI

**Documents considered to be relevant:**

Category	Identity of document and relevant passage	Relevant to claims
X	EP 0796631 A2 (BRAIN), see Fig 2; column 5, lines 32 to 40, and column 6, lines 7 to 10.	1, 2, 8, 9

<input checked="" type="checkbox"/> X Document indicating lack of novelty or inventive step	<input type="checkbox"/> A Document indicating technological background and/or state of the art.
<input checked="" type="checkbox"/> Y Document indicating lack of inventive step if combined with one or more other documents of same category.	<input type="checkbox"/> P Document published on or after the declared priority date but before the filing date of this invention.
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